CLAIMS

What is claimed:

1. A waveguide optical mode transformer, comprising:

a core formed on a planar substrate structure; and

a predetermined plurality of steps formed into the top surface of the core so as to vertically taper the core, each step having a predetermined height and a predetermined length.

2. The waveguide optical mode transformer of claim 1, wherein the core is horizontally tapered.

3. The waveguide optical mode transformer of claim 2, wherein the vertical and horizontal tapers narrow at the same end of the core.

4. The waveguide optical mode transformer of claim 1, further comprising a dielectric cladding layer formed over the core.

5. The waveguide optical mode transformer of claim 1, wherein the planar substrate structure includes a dielectric layer formed over a semiconductor substrate.

6. The waveguide optical mode transformer of claim 1, wherein the core is crystalline silicon.

7. The waveguide optical mode transformer of claim 1, further comprising dielectric layers formed under and over the core, wherein the dielectric layers each have a refractive index that is lower than the refractive index of the core.

8. An optical system, comprising:

a planar waveguide; and

a tapered waveguide extension formed at the end of the planar waveguide for coupling light between the planar waveguide and an optical fiber, the waveguide

extension having a predetermined plurality of steps formed into its top surface so as to vertically taper the waveguide extension, each of the steps having a predetermined height and a predetermined length.

9. The optical system of claim 8, wherein the tapered waveguide extension is horizontally tapered.

10. The optical system of claim 8, wherein the tapered waveguide extension includes a crystalline silicon core.

11. The optical system of claim 10, wherein the tapered waveguide extension includes a dielectric cladding layer formed over the core.

12. The optical system of claim 8, wherein the tapered waveguide extension includes a core layer between two dielectric layers, wherein the dielectric layers each have a refractive index that is lower than the refractive index of the core.

13. The optical system of claim 8, further comprising the optical fiber.

14. A method of manufacturing a tapered planar waveguide usable as an optical mode transformer between an optical fiber and a planar waveguide, comprising:

providing a layer of core material for the tapered waveguide; and

forming a predetermined plurality of steps into the top surface of the core so as to vertically taper the core layer, each step having a predetermined height and a predetermined length.

15. The method of claim 14, further comprising:

forming a horizontal taper in the core layer.

16. The method of claim 14, wherein the step of providing includes:

providing a starting material comprising a substrate, a dielectric layer formed on the substrate, and the layer of core material formed on the dielectric layer.

17. The method of claim 14, wherein the step of forming includes:

(a) defining the location of the wider end of the tapered waveguide on the core layer;

(b) applying a protective layer over a predetermined area of the core layer extending from the defined wider end location, the predetermined area defining the area one or more of the steps;

(c) etching the remaining unprotected area of the core layer to a predetermined depth defining the height of a step; and

(d) repeating steps (b) – (c) a predetermined number of times, each time extending the predetermined area farther from the defined wider end location to define the length of a new step, whereby forming the predetermined plurality of steps.

18. The method of claim 14, wherein the step of etching is performed using silicon dry etching.

19. The method of claim 14, further comprising polishing the wider end of the tapered waveguide.

20. The method of claim 14, further comprising applying an anti-reflective coating at the wider end of the tapered waveguide.